UDC 621.396.623-182.3
:79.096

BBC

1969
THE QUEEN'S AWARD
TO INDUSTRY

RESEARCH DEPARTMENT

REPORT

Car radio reception tests: Winter 1968/9

No. 1969/51

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION

RESEARCH DEPARTMENT

CAR RADIO RECEPTION TESTS: WINTER 1968/9

Research Department Report No. **1969/51**
UDC 621.396.623–182.3
: 79.096

This Report may not be reproduced in any form without the written permission of the British Broadcasting Corporation.

It uses SI units in accordance with B.S. document PD 5686.

C.R.G. Reed, M.A.(Oxon), C.Eng., M.I.E.E.
J.G. Spencer

D. Maurice

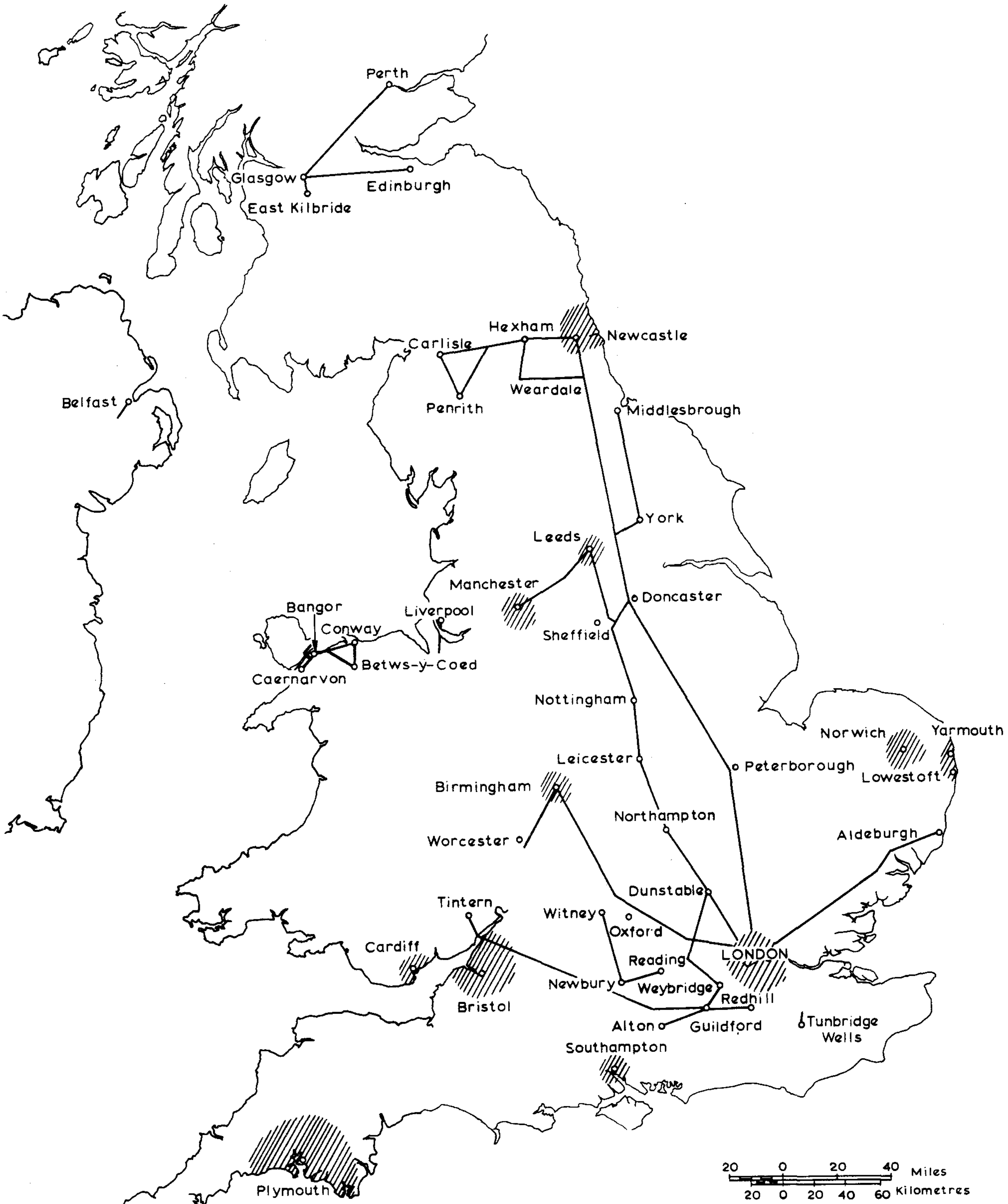
Head of Research Department

(RA-52)

Research Department Report No. **1969/51**

CAR RADIO RECEPTION TESTS: WINTER 1968/9

Section	Title	Page
	SUMMARY	1
1.	INTRODUCTION	1
2.	THE SCOPE OF THE INVESTIGATION	1
3.	RECEPTION OF LOW-FREQUENCY AND MEDIUM-FREQUENCY TRANSMISSIONS	1
	3.1. The Low-Frequency (200 kHz) Radio 2 Transmission	1
	3.2. The Medium-Frequency Services	2
	3.3. General Remarks on Low- and Medium-Frequency Reception	2
4.	RECEPTION OF V.H.F. TRANSMISSIONS	2
	4.1. General Considerations	2
	4.2. Routes, not in Built-Up or Hilly Areas, Within the Service Area of One Transmitter	3
	4.3. Routes in Heavily Built-Up or Hilly Areas	3
	4.4. Routes Through More Than One Service Area	3
5.	STATISTICAL SUMMARY OF THE OVERALL RESULTS	3
6.	A COMPARISON BETWEEN THE TWO TYPES OF RECEIVER	4
7.	CONCLUSIONS	4
8.	ACKNOWLEDGEMENTS	5
	APPENDIX	6



Topographical information based upon the Ordnance Survey map with the sanction of the Controller of H.M. Stationery Office. "Crown Copyright reserved".

Fig. 1 - Routes and areas covered by the survey

Roads traversed —

Areas covered ▨

December 1969.

Research Department Report No. **1969/51**
UDC 621.396.623–182.3
: 79.096

CAR RADIO RECEPTION TESTS: WINTER 1968/9

SUMMARY

During the winter of 1968/9 observations on car radio reception in the U.K. were made by a number of BBC staff. Questionnaires were completed by 29 participants covering the reception quality of BBC services in the low-frequency (l.f.), medium-frequency (m.f.) and very-high-frequency (v.h.f.) bands.

Analysis showed that the single l.f. transmitter provided a reliable service over most of England and Wales. The quality of reception of the m.f. services could not be related very closely to the median field strength, particularly at night when fading and interference severely limit the useful service areas. Both l.f. and m.f. services were relatively free from local variations of signal level, even in hilly terrain, apart from brief drop-outs under bridges or power lines.

Reactions to the v.h.f. services were very mixed. Over half of the assessments rated v.h.f. as 'worse' or 'much worse' than m.f. and it was only on short journeys, such as daily commuting, that an appreciable proportion of the replies rated v.h.f. as 'better than' or 'much better than' m.f. reception. The limit of the useful service area of a transmitter for car radio reception on v.h.f. corresponds fairly closely to the field-strength contour of 1 mV/m at 10 m above ground level. Proposals are made for ways in which the v.h.f. service could be made more acceptable for car radio reception.

1. INTRODUCTION

The BBC sound broadcasting services were developed for home listening but increasing use is being made of car receivers. The relative advantages of the low-, medium- and very-high-frequency services for car radio reception were investigated during the winter of 1968/69 by issuing a questionnaire to a small number of members of the BBC staff in many parts of the country. This questionnaire and the explanatory notes that accompanied it are reproduced in the Appendix.

This report is an analysis of the comments made in the replies to the questionnaires.

2. THE SCOPE OF THE INVESTIGATION

Completed questionnaires were returned by 29 participants, all except three of whom were in Engineering Division. Nine of them used a type of receiver that will be referred to as Receiver A and the other twenty used a type that will be referred to as Receiver B, all of which were fitted by specialist trade installers.

Several participants sent in details of more than one journey or divided a long journey into sections which differed from each other in some significant way, giving a total of 55 reports. The routes and areas covered are shown in Fig. 1.

3. RECEPTION OF LOW-FREQUENCY AND MEDIUM-FREQUENCY TRANSMISSIONS

3.1. The Low-Frequency (200 kHz) Radio 2 Transmission

The l.f. transmitter provides a reliable service over most of England and Wales, the signal strength being very steady and virtually independent of normal variations in terrain and building density. In Devon and Cornwall, in the extreme north of England, in Scotland and in Northern Ireland, where the signal strength is below 10 to 15 mV/m, reception tends to be noisy and there can be significant fading. It is a great advantage in mobile reception that the one transmission covers nearly all of Britain so that it is not necessary to change the tuning of the receiver even on a long journey. Furthermore, tuning is not critical on the l.f. band. However, car aerial systems are of comparatively low efficiency on this waveband and the signal-to-noise ratio tends to be lower than for other services, particularly in the areas more remote from Droitwich. The limited audio bandwidth of the channel, compared with v.h.f., was also the subject of adverse comment.

There were no reports of interference by other broadcasting stations, but in parts of Devon and Cornwall interference from television receiver line-scan radiation was reported.

3.2. The Medium-Frequency Services

While the l.f. service covers a large part of Britain, the need for alternative programmes calls for the use of other frequency bands. The service areas of m.f. transmitters are appreciably smaller than that of the l.f. transmitter and reception of a programme over the whole length of a long journey will require at least one change of receiver tuning but this presents little difficulty.

The grading of the quality of reception of m.f. transmissions shows very little correlation with the received field strength and is primarily determined either by interference from another transmitter or by fading. Reception is little affected by the terrain through which the car is driven, but there were a few reports of a drop in signal level when passing under a bridge or overhead wires.

In daylight the most serious interference effects are experienced with the co-channel network of Radio 1 transmitters. While the main population centres are well served, with typical gradings (Question 2, scale 2) of 1 or 2, the routes from one centre to another pass through the areas of co-channel mush with a typical grading of 5. The medium-frequency Radio 2 service in the Lowlands of Scotland shows the same variation.

The Radio 3 transmission from Daventry serves a large proportion of England including the Midlands and London but reports of weak reception have come from the Sussex coast, Somerset and Norwich. The service is poor in Wales and there are areas in the North of England where the signal is weak and subject to co-channel beats that are believed to involve the Daventry and the Lisnagarvey and/or Newcastle transmitters. In the Lowlands of Scotland the Radio 3 service is good except in the central mush area.

The daytime reception of Radio 4 is generally good and there are few places in well-populated areas in which the grading of the received signal is not 1, 2 or 3.

At night time all the m.f. services deteriorate: the co-channel effects that are found during the daytime become much worse, the signals are subject to fading and there is interference from Continental transmissions.

3.3. General Remarks on Low- and Medium-Frequency Reception

Adverse comment has been received on the limited a.f. bandwidths of l.f. and m.f. reception relative to v.h.f. It could be thought that conditions for listening to car radio, involving as they do a high acoustic noise level and many other distractions – especially for the driver – would render valueless the extended frequency range available on the v.h.f. services, and one reply to the questionnaire did in fact express this view. On the other hand, nine replies, detailing 11 journeys, commented favourably on the wider audio bandwidth available with v.h.f. and it is clear that the restriction of the higher a.f. components in the output when receiving a signal on the l.f. or m.f. bands reduces the pleasure of listening to a car radio. The effect may have been exaggerated, though, for users of Receiver B because optimum reception required re-adjustment of the tone control when switching between m.f. and v.h.f.

On the other hand, the restricted dynamic range of an l.f. or m.f. transmission, relative to v.h.f., is an advantage in a car because the background acoustic noise level is high and very quiet passages of the programme might be lost. At very high speeds many cars are so noisy that there were reports of even the m.f. service being unusable for much of the time.

4. RECEPTION OF V.H.F. TRANSMISSIONS

4.1. General Considerations

Reports on the reception of v.h.f. signals vary from 'very good' to 'useless' and a consistent pattern only emerges when the reports are related to the types of area in which the journeys were made. A distinction must be drawn, too, between the assessments of the v.h.f. service itself, as shown in the answers to Questions 1, 2 and 3, and the comparisons with the m.f. service, as shown in the answers to Question 4, which clearly depend also on the quality of the m.f. service in the area.

Two themes that recur throughout the reports are the difficulty in suppressing interference at v.h.f. due to electrical noise generated in the vehicle and criticisms of the tuning arrangements of the receivers. While suppression of a vehicle at l.f. or m.f. seems to be an understood art, the position is very different at v.h.f. and there are several comments on the failure of the installers of the receiver to provide adequate suppression to protect the listener against interference caused by his own car. Apart from this, iginition interference was suffered from other cars. The suppression regulations now in force are based on the requirements for the protection of home reception of Band I television, and existing suppression (except for the few cars fitted with v.h.f. radios) is often inadequate for the protection of v.h.f. reception in other vehicles. A few reports were also received of interference by both base and mobile transmitters of taxi and other mobile services.

There were also difficulties associated with tuning although both types of receiver used had push-buttons for channel selection. In some cases these were unsatisfactory mechanically, and there were many criticisms of the difficulties experienced by drivers in adjusting the tuning to the required signal – one report mentioned three minor mishaps occurring during frequency changes! Both types of receiver used in these tests had a.f.c. systems, but several reports gave the impression that the control was not operating satisfactorily and there was criticism of the tendency for the receivers to become detuned, either by slow drift or because of vibration. These comments applied particularly to Receiver B.

In some areas it was difficult to judge which of many signals available was strong and likely to give good service, and which was relatively weak and more likely to be lost because of a turn or dip in the road. In addition to there being local variations in the field strengths there is also the possibility that the strongest signal at one point in the journey may not be the most useful one over several miles, particularly if it is received from a transmitter that is of low power or has a directional aerial.

Multipath distortion was mentioned in only a few of the reports, and with one exception these related to reception at points very close to a high power transmitter, e.g. within 1 km. At these short distances other effects could occur that might be mistaken for multipath distortion, the most important being:

(i) Intermodulation can be produced in the receiver between three or four transmissions from the one aerial, at uniformly-separated mean carrier frequencies, that are fed into the receiver at very high level.

(ii) The vertical radiation pattern of the transmitting aerial contains, at angles approaching the vertical, lobes and minima which sweep across the ground as the transmitter is frequency modulated. This may produce amplitude changes that are too large to be removed by the limiting action of the receiver.

(iii) The high signal level can result in detuning of the local oscillator of the receiver, producing distortion either because the discriminator no longer operates over the linear part of its characteristic or because the variations in amplitude described in (ii) above cause distorted frequency modulation of the local oscillator.

No tests have been made to confirm the causes of the reported distortions.

Although there were minor variations in the assessments of the grade of service in areas from which there were several reports, the limit of useful service area of a v.h.f. transmitter for reception in a car was found to correspond closely with the contour representing a field strength of 1 mV/metre at 10 m above ground level.

The reports on car radio reception at v.h.f. may be divided broadly into three classes, depending on the route taken;

(i) Routes in open country which stay within the service area of one transmitter.

(ii) Routes in either heavily built-up or hilly areas where the field-strength received from the local transmitter varies between very wide limits and there is no alternative available.

(iii) Routes which pass from the service area of one transmitter to another, involving retuning of the receiver.

These are considered in turn.

4.2. Routes, not in Built-Up or Hilly Areas, Within the Service Area of One Transmitter

Some routes were well served by a single v.h.f. transmitter and these account for nearly all the answers to Question 4 that were favourable to v.h.f. The areas from which these favourable reports were received included the N.W. sector of the London area, Birmingham, Belfast, Devon, Norfolk, Oxfordshire and the Lowlands of Scotland.

4.3. Routes in Heavily Built-Up or Hilly Areas

In these areas the received signal strength varies considerably from place to place, even over quite short distances, and there are places where the noise output from the receivers rises seriously and the signal itself may disappear. Reports of such reception have been received from parts of the area of the North Downs to the south-west of London, Wales, the Pennines and parts of Scotland. Reports from parts of Devon and Cornwall show a tendency towards this pattern but the effects are less severe and the v.h.f. signal is considered better than the local m.f. and l.f. signals which tend to be weak. Some of these hilly areas are very close to a v.h.f. transmitter and in places the road runs at the top of a ridge where the signal strength is very high and the receiver overloads, as described in the Section 4.1.

4.4. Routes Through More Than One Service Area

Sections 4.2 and 4.3 dealt with comparatively short journeys within the service area of a single transmitter. A totally different situation occurs on long journeys when the route passes through the service areas of two or more transmitters. Retuning the receiver involves two problems; firstly, the listener needs to have a fairly accurate idea of the frequency to which to tune and secondly, there is a certain amount of difficulty in making the necessary adjustments. For example, when driving along a main road there may come a point at which the driver should retune to the transmitting station which serves his desitnation area. There may then be a problem in selecting that station rather than, say, a third station in a direction at right angles to the route, which may give a good signal at that point but whose signal will have fallen to an unusable level before arriving at the destination, requiring a second retuning.

Although the receivers had push-button station selectors this did not make the situation much easier. It would be difficult for a driver to pre-set the buttons to the correct channels before starting out unless he did so on a previous journey over the same route. Even if he had pre-set the channels fine adjustment of the tuning might still be necessary, to minimize impulsive noise interference.

In regions where two service areas overlap, the median field strengths of the two transmissions may be very similar. If the frequency difference between the carriers is small, a receiver with a.f.c. may switch to-and-fro between them; examples of this were reported.

5. STATISTICAL SUMMARY OF THE OVERALL RESULTS

The mean values of the grading assessments in the answers to the questionnaire, which is reproduced in the Appendix, are given in Tables 1 and 2. Some apparent anomalies in the figures are discussed in Section 6.

TABLE 1

The Mean Assessments of the Overall Grades of Service (Question 2)
Using Six-Grade Quality Scale (Scale 2)

	V.H.F. R-2,3,4	V.H.F. Local	M.F. R-1	M.F. R-2	M.F. R-3	M.F. R-4	L.F. R-2
Receiver A	2·7	2·0	2·1	2·0	2·0	1·7	2·2
Receiver B	3·7	4·0	2·9	2·0	2·6	2·3	1·9
All receivers	3·2	2·8	2·6	2·0	2·4	2·1	2·0

TABLE 2

The Mean Assessments of Comparison of the v.h.f. and l.f. Services with m.f. (Question 4)
Using Seven-Grade Comparison Scale (Scale 3)

	V.H.F. R-2,3,4		L.F. R-2	
	mean	stand.dev.	mean	stand.dev.
Receiver A	−1·5	1·4	−0·3	1·5
Receiver B	−0·8	2·3	+0·7	1·3
All receivers	−1·1	2·2	+0·2	1·5

Considering the reception of v.h.f. Radio 2, 3 and 4 (omitting Local Radio because it was so little mentioned in the reports), just over one-half of the replies to Question 4 rated v.h.f. relative to m.f. as Grade −2 or −3, with approximately one-third of the total replies rating it at −3. When the reports are divided into 'local journeys' (daily commuting or journeys up to approximately 30 km) and 'long journeys' (those above approximately 50 km) the proportion of assessments in Grade −3 or −2 in each section is very similar to that in the assessments taken as a whole, each being just over 50%, but the proportions of assessments at Grade +2 or +3 are very different for the two sections. About one-third of the 'local journey' assessments were Grade +2 or +3, but only two out of 28 (7%) of the 'long journey' assessments had this grading, one of which was in an area with a rather poor m.f. service and the other was along a route that is unusually well served at v.h.f.

6. A COMPARISON BETWEEN THE TWO TYPES OF RECEIVER

The distribution of the two types of receiver among the participants in the tests did not follow any consistent pattern but there was a tendency for Receiver A to be used by the more senior members of the staff. This was, to some extent, reflected in the difference between the proportions of the three different types of journey reported (Sections 4.2 to 4.4), those involving a change of frequency when using the v.h.f. band (described in Section 4.4) representing approximately 44% of all the reports from users of Receiver A but only 14% of all those from users of Receiver B. The reported journeys which did not involve a change of frequency when using the v.h.f. band were, for each type of receiver, divided almost equally between those in open country (Section 4.2) and those in hilly or built-up areas (Section 4.3).

It is seen from Table 1 that, if the m.f. Radio 2 and v.h.f. Local Radio figures are omitted beacuse there are very few examples in the replies, Receiver A is better than Receiver B on the m.f. band and distinctly better on the v.h.f. band and is marginally less satisfactory than Receiver B on the l.f. band. The mean gradings given in Table 1 show a preference by users of both receivers for l.f. or m.f. over v.h.f. for car radio reception. This is confirmed by the figures of Table 2.

There appears to be a greater unanimity on preferring m.f. to v.h.f. among the users of Receiver A than among the users of Receiver B. Although only one out of 23 reports from users of Receiver A was favourable to v.h.f. the 28 reports from users of Receiver B included 10 which were favourable to v.h.f. while the 18 unfavourable replies included 11 which rated v.h.f. as 'much worse' than m.f. This difference is probably due more to the types of journey undertaken by the individuals to whom the receivers happened to be issued than to the receivers themselves.

Although Table 2 shows the more marked preference for m.f. over v.h.f. by users of Receiver A, the gradings of the quality of service in Table 1 show a greater arithmetical difference between the mean grades of the v.h.f. and m.f. services for Receiver B than Receiver A. This is probably due to two features of the systems of grading the quality of reception. Firstly, assessments using Scale 2 (the absolute scale of quality from 1 = Excellent to 6 = Very Poor) involve different impairments on the l.f./m.f. services from those on the v.h.f. services, and as a result the standards of judgement may be different. Secondly the numerical values used in Scale 2 only indicate an order of preference of the conditions assessed, and arithmetical processes involving these numbers, such as taking differences or averages, may have little significance or may need considerable care and thought in their interpretation.

7. CONCLUSIONS

The l.f. Radio 2 service was consistently good over most of England and Wales but in the areas more remote from the transmitter at Droitwich there was some fading and a low signal-to-noise ratio.

The m.f. services were generally satisfactory in daylight except that the coverage of Radio 3 was somewhat restricted and there were 'mush areas' on the Radio 1 service and, in Scotland, on the m.f. Radio 2 service. There is little correlation at m.f. between the received field strength and the grade of service, but there were few areas in which the reception in daylight was not assessed at Grade 3 or better for at least one Radio 4 transmitter. At night the fading was worse and there was considerable interference by Continental stations.

There was a very mixed reaction to the v.h.f. services for car radio reception, with more than half of the assessments rating v.h.f. reception as 'worse' or 'much worse' than m.f. (Grade −2 or −3). In some areas the results were excellent and the greater a.f. bandwidth compared with the other services was a favourable point that was often mentioned. In other areas, where the signal level was low or very variable, the noise level in the receiver output varied widely and rapidly. It was found that the service area for car-radio reception on v.h.f. corresponded fairly closely with the field-strength contour of 1 mV/m at 10 m above ground level.

The most important criticisms of the receivers on the v.h.f. band – particularly Receiver B – were that the tuning controls were difficult to adjust and that the frequency stability was not good enough, in terms of both slow drift and changes due to vibration. As the car passes from the service area of one transmitter to another the new channel must be identified and the receiver tuned to it: this is both more frequently required and more difficult to achieve on the v.h.f. than on the m.f. band. There have also been reports of severe distortion in areas of very high field strength.

Radio interference suppression of a car for the l.f. and m.f. bands appears to be achieved with no difficulty but the problems are much greater on the v.h.f. band and at present car-radio installation staff have comparatively little experience of suppression at v.h.f. A better understanding is needed of the techniques involved in suppressing not only whe whole of the electrical system but also, in some cases, the effects of electrostatic discharges.

The v.h.f. network represents a considerable investment of resources and the possibilities of erecting transmitters on new sites, of using other than horizontal polarization of the radiated signal or of increasing the power of existing transmitters are limited by their cost as well as by the potential increase of co-channel interference in other areas. In view of the findings regarding v.h.f. reception in cars there appears to be scope for improvement in the following respects, without which the v.h.f. services are unlikely to be acceptable for general use in cars.

(i) The tuning arrangements of the receivers, and their frequency stability, require further attention by the receiver designers.

(ii) At present the service area for satisfactory reception on v.h.f. with a well-installed car radio corresponds closely to a field strength at 10 m above ground level of 1 mV/m; the limit of the v.h.f. service for domestic listening is based on a field strength of 250 μV/m. The use of better receivers and car aerials could give only a limited increase in service area unless there were a marked improvement in the standard of interference suppression. While this applies particularly to cars fitted with v.h.f. receivers, it is also important that all vehicles should be suppressed adequately to protect reception on the road.

(iii) Ways should be sought of helping the motorist, and particularly the unaccompanied driver, to identify and tune his receiver to the appropriate transmission of the programme that he wishes to hear. This is particularly important for long journeys on trunk roads where retuning is needed more frequently for v.h.f. than for m.f. reception.

In addition to these basic requirements it might be mentioned here that, in Sweden, serious consideration is being given to more advanced receiving techniques to improve the convenience and quality of f.m. car reception. These include the use of a vertical ferrite rod receiving aerial, diversity reception using two aerials, and automatic station selection using ultrasonic tones to identify programmes. Even if all of these techniques were successfully developed and applied in the U.K. it could well be that Band II f.m. reception was only equal to l.f. and m.f. reception in potential general performance and reliability but at a considerably greater cost, particularly of the receiving equipment.

8. ACKNOWLEDGEMENTS

The authors wish to express their thanks to all those who completed and returned Questionnaires. The replies contained a wealth of detailed information on which this Report is based.

APPENDIX

The Questionnaire and Notes, Copies of Which Were Sent to All Participants

CAR RADIO RECEPTION QUESTIONNAIRE

Name: . . . .

Model of car: . . . .

Model of car radio: . . . .

Type and location of aerial (e.g. vertical rod on front offside, sloping rod on roof, etc.): . . . .

. . . .

Area in which tests carried out: . . . .

Period covered by tests: . . . .

1. Assessment of impairments of service (Scale 1)

Transmission	Grade of impairment		
	Hiss and impulsive noise	Other interference	Variations of volume
V.H.F. (Radio 2, 3 and 4)			
V.H.F. (Local radio)			
M.F. (Radio 1)			
M.F. (Radio 2)			
M.F. (Radio 3)			
M.F. (Radio 4)			
L.F. (Radio 2)			

2. Assessment of overall grade of service (Scale 2)

Transmission	Grade	Remarks
V.H.F. (Radio 2, 3 and 4)		
V.H.F. (Local Radio)		
M.F. (Radio 1)		
M.F. (Radio 2)		
M.F. (Radio 3)		
M.F. (Radio 4)		
L.F. (Radio 2)		

3. Convenience of use of receiver (Scale 2)

Service	Grade	Remarks
V.H.F. M.F. L.F.		

4. Comparison of v.h.f. and l.f. services with m.f. (Scale 3)

Service	Grade	Remarks
V.H.F. L.F.		

5. Conditions of test (Please tick as applicable)

(i) Traffic density was:—

Generally light	About equal periods of light and heavy	Generally heavy

(ii) The windscreen wipers and heater/ventilator motor were operating:—

	Never	A small proportion of the time	About half the time	Most of the time	All the time
Wipers					
Heater motor					

(iii) The tests were carried out:—

Entirely in daylight	Chiefly in daylight	With about equal periods of daylight and darkness	Chiefly in darkness	Entirely in darkness

6. Any other observations

NOTES ON CAR RADIO RECEPTION QUESTIONNAIRE

1. The purpose of this series of tests is to assess the grade of service provided to car radio users by the existing v.h.f. transmitter network, both in absolute terms and also as compared to that provided by the m.f. and l.f. services.

2. The information asked for in the attached questionnaire should represent the average performance over the whole area and period in which the tests are carried out. You are asked to give your assessments as a single grade; you will appreciate that an answer of 'grade 1 to 6' for example, though it may be factually true, is of little value for the purposes of this investigation. If the grade of reception, on any service, varies so greatly that an assessment of the average would be difficult or meaningless, please subdivide your tests into appropriate sections and complete a separate questionnaire for each section.

3. The grading scales to be used are as follows:—

Scale 1		Scale 2		Scale 3	
Grade	Description	Grade	Description	Grade	Description
1	Imperceptible	1	Excellent	–3	Much worse
2	Just perceptible	2	Good	–2	Worse
3	Definitely perceptible but not disturbing	3	Fairly good	–1	Slightly worse
4	Somewhat objectionable	4	Rather poor	0	Same
5	Definitely objectionable	5	Poor	+1	Slightly better
6	Transmission unusable	6	Very poor	+2	Better
		X	Unreceivable	+3	Much better

4. Question 1 asks you to assess the levels of various impairments of the received signal.

   Hiss noise, which sounds rather like escaping steam and is generated in the early stages of the receiver itself, and impulsive noise, which is a succession of 'clicks' or 'plops' and is generated by the electrical equipment in your own and adjacent vehicles, are sometimes difficult to distinguish from each other. For this reason you are asked to assess them together.

   'Other interference' includes all forms of interference other than hiss and impulsive noise. The type of interference most likely to be encountered under this heading is that caused by other transmissions. This will generally manifest itself on the m.f. and l.f. bands as a background of another programme, which may be distorted and may be accompanied by a whistle. On the v.h.f. band it will generally appear as a background of another programme, probably distorted, or as an irregular 'swishing' noise.

   The variations in volume are caused by changes in the level of the received signal. The rate of variation can be anything from a slow fade, occupying a period of minutes, to a rapid flutter. On the m.f. band they are more likely to occur during the hours of dusk or darkness but on the v.h.f. band they can occur at any time.

5. In Question 2 you are asked to give an overall assessment of the grade of each service. This grading should take into account the impairments referred to in Question 1 plus any other factors, such as quality of reproduction.

6. Question 3 covers all factors contributing to the ease with which the services can be received on each band, including ease of tuning, ability to identify and select the desired transmission, tuning drift, necessity to re-tune to different transmissions on long journeys, etc.

7. Question 4 asks for an overall comparison of the v.h.f. and l.f., relative to the m.f. services, taking into account all the factors mentioned in previous questions plus any others you think relevant.

SMW

Printed by BBC Research Department, Kingswood Warren, Tadworth, Surrey